EVALUATION OF SERVICE SUPPLY CHAIN PERFORMANCE CRITERIA WITH DANP METHOD [(*)]

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Abstract

Despite the service industry composes large part of the world economy, the academic studies and applications on supply chain are mainly about production industry. Because of the different structure of services, the service supply chain and also performance criteria-metrics differ from the product supply chain. The aim of this paper is to evaluate the supply chain performance metrics for restaurant sector. For this purpose in the first and second part of the paper the service supply chain concept and service performance metrics that has been widely accepted in the literature are explained. Due to the non-hierarchical structure of performance criteria and metrics, the hybrid multi criteria decision making method DANP (DEMATEL Based Analytic Network Process) is used to weight the criteria and the information about the method is given in the third part. In the application part, with the data received from the expert group about a restaurant supply chain, firstly the direct relaxation matrix has been generated and relations between main performance criteria are determined with DEMATEL (Decision Making Trial and Evaluation Laboratory) method. Then the weights of per performance metric and criterion were computed with DANP. Analysis results have demonstrated that the "customer satisfaction, flexibility and customer query time" are the most important metrics impacting the restaurant supply chain performance.

Keywords: Service Supply Chain Performance, DANP (DEMATEL Based Analytic Network Process)

Özet

Hizmet sektörü dünya ekonomisinin büyük bir bölümünü oluşturmasına rağmen, tedarik zinciri ile ilgili akademik çalışmalar ve uygulamalar genellikle üretim sektörü ile ilgilidir. Hizmetlerin farklı yapısı nedeniyle hizmet tedarik zinciri ve performans kriterleri-ölçütleri ürün tedarik zincirinden farklıdır. Bu çalışmanın amacı restoran sektörü için tedarik zinciri performans ölçütlerinin değerlendirilmesidir. Bu amaçla çalışmanın ilk bölümünde hizmet tedarik zinciri kavramı ve literatürde genel kabul görmüş hizmet perfomans ölçütleri açıklanmıştır. Performans kriterlerinin ve ölçütlerinin hiyerarşik olmayan yapısından dolayı kriterlerin ağırlıklandırılmasında hibrit bir çok kriterli karar verme yöntemi olan DANP (DEMATEL Tabanlı Analitik Ağ Süreci) kullanılmış ve ikinci bölümde yöntemle ilgili bilgi verilmiştir. Uygulama bölümünde restoran tedarik zinciri ile ilgili uzman grubundan elde edilen veriler ile ilk olarak direkt ilişki matrisi oluşturulmuş, ardından DEMATEL yöntemi ile ana performans kriterleri arasındaki ilişkiler belirlenmiştir. Daha sonra DANP yöntemiyle her bir performans ölçütü ve kriteri için ağırlıklar hesaplanmıştır. Analiz sonuçları "müşteri tatmini, esneklik ve sipariş alma süresi"nin restoran hizmet tedarik zinciri performansını etkileyen en önemli ölçütler olduğunu ortaya koymuştur.

Anahtar Kelimeler: Hizmet Tedarik Zinciri Performansı, DANP (DEMATEL Tabanlı Analitik Ağ Süreci)

تقييم معايير الاداء
بين طريقة DANP و سلسلة خدمة التوريد

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ملخص

على الرغم من أخل قطاع الخدمة يشكل قسم كبير من الاقتصاد, فان سلسلة التوريد المتعلقة بالدراسات الأكاديمية و تنفيذها بشكل عام يرتبط بقطاع الانتاج. وبسبب اختلاف هيكليات الخدمة وسلسلة توريد الخدمة ومعايير الأداء فان معاييرها تختلف عن سلسلة امداد المنتج. الهدف من هذه الدراسة لـ قطاع المطاعم هو تقييم معايير أداء سلسلة التوريد. في الجزء الأول من هذه الدراسة بهذا الغرض تم توضيح معايير أداء الخدمة المقبولة عموما في أدب ومفهوم سلسلة توريد الخدمة. وبسبب عدم هرمية هيكلية معايير ومقايسس الأداء وفي موضوع ترجيح المعايير تم اعطاء معلومات متعلقة بالادارة في القسم الثاني وتم باستخدام DANP (مرحلة شبكة التحليل بقاعدة DEMATEL) والذي هو ادارة اعداء القرار الهجيني لكثير من المعايير. وفي قسم التنفيذ و التطبيق تم تشكيل مصفوفة العلاقة المباشرة مبدئيا من خلال البيانات التي تم الحصول عليها من مجموعة الخبراء ذات الصلة في سلسلة توريد المطعم, وبعدها تم توضيح و تبيان العلاقات الموجودة بين معايير الاداء الرئيسية و ادارة DEMATEL. نتائج التحليل كانت بأن من أهم معايير المؤثرة في أداء سلسلة توريد خدمة المطاعم هي " رضاء العميل والمرونة و مدة أخذ الطلب ".

الكلمات المفتاحية : أداء سلسلة توريد الخدمة, DANP (مرحلة شبكة التحليل بقاعدة DEMATEL)

1. INTRODUCTION

Service sector has rapidly increasing share in world economy and constitutes 63.6 % of the world's GDP in respect of 2013 (CIA World Factbook). Nevertheless, most of the scientific methods and topics are mentioned for manufacturing. One of these methods is supply chain management (SCM). Supply chain theory focused mainly on manufacturing sector for many years. Because of the structural differences between goods and services, a specific supply chain model was needed for services. Ellram et al. (2004) introduced widely well accepted service supply chain model that is independent from manufacturing supply chain models. They defined service supply chain management as; "management of information, processes, capacity, service performance and funds from earliest to the ultimate customer." Then Baltacioglu et al. (2007) proposed a new service supply chain model.

Businesses are competing in continuously changing environments. In order to respond these changes, they require monitoring performance information frequently. So, performance measurement is essential for sustainability in the business. Performance measurement is defined as "the processes of quantifying the effectiveness and efficiency of action" by Neely et al. (1995). Performance measurement provides the necessary information for management feedback for decision makers and process managers (Chan, 2003). The measurement results reveal the effects of strategies and potential opportunities in supply chain management (Bhagwat and Sharma, 2007). Hence, identifying and evaluating the required and proper performance measures is necessary.

In this paper we aimed to generate the relation network structure of performance dimensions/criteria of service supply chain and determine the most important performance dimensions and criteria and we applied DANP method on a restaurant supply chain. For this purpose the paper is organized in 5 Section. Section 2 is allowed for literature on service supply chain performance metrics and measurement. Section 3 explains DEMATEL and DANP methods that are used for the application. Section 4 proposes the application of DEMATEL and DANP techniques to evaluate the service supply chain performance metrics for restaurant sector. Finally, in Section 5 the paper is summarized, limitations of the research are mentioned and recommendations for further research are given.

2. LITERATURE REVIEW ON SERVICE SUPPLY CHAIN PERFORMANCE MEASUREMENT METRICS

In this section, the literature on service supply chain performance measurement metrics is featured. There is a little study about Service Supply Chain Performance Management especially on the performance metrics. Fitzgerald and Moon (1996) had investigated 26 performance measures in two main category; result dimensions and determinants for service businesses. Financial performance and competitiveness were specified as the result dimensions. Resource utilization, quality of service, innovation and flexibility were defined as determiner. According to Ellram et al. (2004), there are seven metrics of service supply chains including; information flow, capacity and skills management, demand management, customer relationship management, supplier relationship management, service delivery management and cash flow. Li et al. (2005) used delivery dependability and time to market for evaluating the predictive validity of their six SCM constructs. The six constructs analyzed in their research included strategic supplier partnership, customer relationship, information sharing, information quality, internal lean practices and postponement.

Sengupta et al. (2006) have analyzed the eight supply chain management strategies (Information sharing, product & service customization, long-term relationships, hedging strategies , advanced planning systems, leveraging the internet, supply network structure and distribution network structure) and their effects on specific operational and financial performance. The results showed the similarities and differences between the manufacturing and service supply chains that their organizational performances.

Baltacıoğlu et al. (2007), developed a new model for service supply chains and applies it to the healthcare industry. This model includes managerial activities that identified as demand management, capacity and resources management, customer relationship management, supplier relationship management, order process management and service performance management. Martin and Patterson (2009) defined three performance measures; inventory, cycle time and financial performance. They used a survey to investigate the use of metrics to determine which one(s) are most useful for measuring as firm performance. They found that inventory and cycle time metrics are the most significant. He et al. (2010) tried to develop a value-oriented model for the management of service supply chain. Firstly, they identified the participants (service providers and customers) of service supply chain, then the service process flow, capacity flow, information flow and value flow among these participants are used to improvement of service supply chain which can optimize the service business processes.

Giannakis (2011) explored the utility of the manufacturing biased SCOR model in services and developed a reference model for use in service organizations. Six performance metrics: cost analysis, time analysis, inventory analysis, forecast analysis, quality analysis and financial analysis were issued in this study. Zhan and Zeng (2011), are used four performance metrics: customer satisfaction, financial condition, cost condition and joint development to make comprehensive estimation for the performance of port service supply chain. According to Kulkarni and Khot (2012), the main criteria's for performance measurement are finance, customer service and internal business process. The performance of supply chain is evaluated by balance score card method and weight age of this three criteria is developed by using AHP method. AHP model is assessing decision-makers to identify and evaluate the supply chain performance. Cho et al. (2012) made a comprehensive literature review about service supply chain performance measurement. As a result of review they composed a hierarchical service supply chain performance model that includes tree assessment areas, ten criteria and twenty eight performance metrics. The developed model was applied by the way of fuzzy AHP for hotel supply chain and customer services had been founded out most important assessment area.

3. DEMATEL BASED ANP METHOD

Many of the multi criteria decision making methods don't consider the relations between criteria. So, the criteria are assumed hierarchical and linear structure. In real world, relations between decision problems criteria's can be network structure and in this case the problem can't be analyzed by linear methods like AHP, TOPSIS, VIKOR etc. Saaty (1996) developed Analytic Network Process method to release this restriction of linear methods. In original ANP method control hierarchy, in other words network relation map is demonstrated presumptively and the unweighted supermatrix is generated by pairwise comparisons to calculate the importance weightiness of the dimensions/criteria. In DANP (DEMATEL Based ANP) method, the network structure and the weightiness of the dimensions are determined by DEMATEL method and the total influence matrix of the DEMATEL method is used to form the unweighted supermatrix for ANP method. DANP is widely used in many areas recent years (Yang et al. 2008; Tseng, 2009b; Tsai and Hsu, 2010; Chen and Tzeng, 2011; Chen et al. 2011; Wang and Tzeng, 2012; Yang and Tzeng, 2011; 2012; Hung et al., 2012; Liu et al., 2013; Çınar, 2013).

DANP have seven solving steps see (Figure 1.). The first four steps are called DEMATEL and the other three steps for ANP. DEMATEL is a multi-criteria decision making method that was developed by Battle Geneva Institute. DEMATEL is utilized to analyze and illustrate the direct and indirect relations among between decision criteria. It has been successfully applied in many area such as supplier selection (Chang et al., 2011), service quality (Tseng, 2009; Cheng et al., 2012), personnel evaluation (Wu et al., 2010), evaluation of key success factors in banking (Wu, 2012), facility location decision (Horng et al. 2013), supply chain management (Uysal, 2012; Wu et al., 2011; Lin et al., 2011) etc. DEMATEL uses matrix calculations to obtain relationships and, produces influence diagraph that separate causer and effecter dimensions/criteria with the results.

DANP method's solving steps are as follows (Chen et al. 2011; Wang and Tzeng, 2012; Su et. al., 2012);

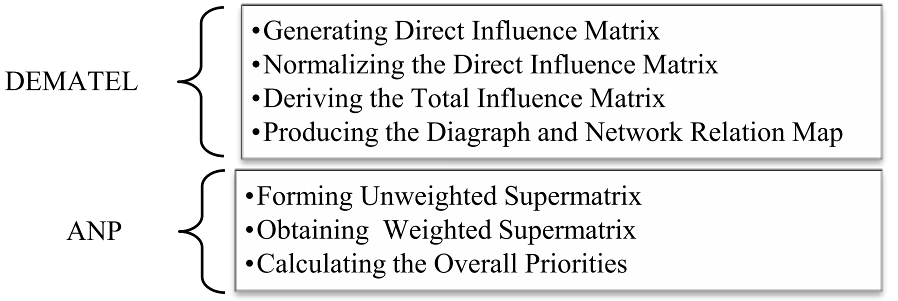

Figure 1. Solving Steps of DANP Method

Step1: *Generating the direct influence matrix*

Respondents are asked to indicate the degree of influence among criteria on a scale of 0, 1, 2, 3, 4 that "Completely no influence (0), Low influence (1), Medium influence (2), High influence (3) and Very High Influence (4)". A $(n \times n)$ matrix is composed with the responses.

Direct influence matrix A can be represented as follows;

$$A = \begin{bmatrix} a_{11} \dots a_{1j} \dots a_{1n} \\ \vdots \quad \vdots \quad \vdots \\ a_{i1} \dots a_{ij} \dots a_{in} \\ \vdots \quad \vdots \quad \vdots \\ a_{n1} \cdots a_{nj} \cdots a_{nn} \end{bmatrix} \tag{1}$$

a_{ij} indicates the influential degree of the criterion i to the criterion j and the diagonal of the matrix is "0".

Step 2: *Normalizing the direct influence matrix*

Normalized influence matrix X is calculated as follows;

$$X = s.A \tag{2}$$

$$\mathrm{s} = \min\left[\frac{1}{\max\limits_{i} \sum_{j=1}^{n} |a_{ij}|}, \frac{1}{\max\limits_{j} \sum_{i=1}^{n} |a_{ij}|}\right] \tag{3}$$

Step 3: *Deriving the total influence matrix*

A continuous decrease of the indirect effects of problems along the powers of matrix X, guarentees convergent solutions to the matrix inverse similar to an absorbing Markov Chain matrix (Yang and Tzeng, 2011). Note that $\lim_{m\to\infty} X^m = [0]_{n\times n}$ where 0 is null matrix and *I* is identity matrix total influence matrix is obtained by

$$T = X + X^2 + \cdots + X^h = X(I - X)^{-1} \tag{4}$$

Step 4: *Producing the diagraph and network relation map*

Let *D* denotes the vector that is consisted row totals of the *T* total influence matrix and *R* denotes the vector that is consisted column totals of the *T*. d_i is the sum of the i th row of matrix *T*, and shows the sum of direct and indirect effects of criterion I on the other criteria. Similarly r_j is the sum of the j th column of matrix *T* and shows the sum of direct and indirect effects that criterion *j* has been received from other criteria.

$$T = \begin{bmatrix} t_{11} \ldots t_{1j} \ldots t_{1n} \\ \vdots \quad \vdots \quad \vdots \\ t_{i1} \ldots t_{ij} \ldots t_{in} \\ \vdots \quad \vdots \quad \vdots \\ t_{n1} \cdots t_{nj} \cdots t_{nn} \end{bmatrix} \tag{5}$$

$$d_i = \sum_{j=1}^{n} t_{ij} \Rightarrow D = \begin{bmatrix} d_1 \\ \vdots \\ d_i \\ \vdots \\ d_n \end{bmatrix}_{n\times 1}$$

(**Hata! Yer işareti tanımlanmamış.**)

$$r_j = \sum_{i=1}^{n} t_{ij} \Rightarrow R = [r_1 \quad \cdots \quad r_j \quad \cdots \quad r_n]_{1\times n} \tag{6}$$

By the help of *D* and *R* vectors the degree of central roles of criteria $(D + R^T)$ and net effects of the criteria to the system $(D - R^T)$ is calculated (R' $indicates\ transpose\ of\ the\ vector\ R$). If net effect of criterion i is positive, the criterion i affects the other criteria and if $(d_i - r_j)$ is negative, it means the criterion *i* is affected by other criteria. The central roles of criteria $(d_i + r_j)$ indicates the degree of relationships with the other criteria (Chen et al., 2011). Influence diagraph can be generated by mapping the calculated pairs of $(d_i + r_j, d_i - r_j)$, the casual relationships dimensions/criteria can be visualized on diagraph.

There are several types of DANP method. Process steps of the DANP method that are proposed by Chen et. al (2011), are as follows;

Step 5: *Forming Unweighted Supermatrix*

The total influence matrix T can be divided into $T_C = [t_{ij}]_{n\times n}$ criteria based matrix and T_D dimensions based matrix. T_D denotes the dimension based total influence matrix and it is achieved from criteria based total influence matrix T_C by averaging the groups/dimensions in itself. Criteria based total influence matrix is shown in Eq.(8).

$$T_C = \begin{array}{c} \\ \\ D_1 \; \begin{array}{c} c_{11} \\ c_{12} \\ \vdots \\ c_{1m_1} \end{array} \\ \vdots \\ D_i \; \begin{array}{c} c_{i1} \\ c_{i2} \\ \vdots \\ c_{im_i} \end{array} \\ \vdots \\ D_n \; \begin{array}{c} c_{n1} \\ c_{n2} \\ \vdots \\ c_{nm_n} \end{array} \end{array} \begin{array}{c} \begin{array}{ccccc} D_1 & \cdots & D_i & \cdots & D_n \\ C_{11} \ldots C_{1m_1} & \cdots & C_{i1} \ldots C_{im_j} & \cdots & C_{n1} \ldots C_{nm_n} \end{array} \\ \begin{bmatrix} T_c^{11} & \cdots & T_c^{1j} & \cdots & T_c^{1n} \\ \vdots & & \vdots & & \vdots \\ T_c^{i1} & \cdots & T_c^{ij} & \cdots & T_c^{in} \\ \vdots & & \vdots & \ddots & \vdots \\ T_c^{n1} & \cdots & T_c^{nj} & \cdots & T_c^{nn} \end{bmatrix} \end{array} \quad (8)$$

Then the total influence matrix is prepared for the unweighted supermatrix. For this purpose the matrix T_c is normalized into matrix T_c^{α} and then T_c^{α} is transposed to achieve unweighted supermatrix W. The process steps are given with Eq (9, 10, 11, 12).

$$T_C^{\alpha} = \begin{array}{c} \\ \\ D_1 \; \begin{array}{c} c_{11} \\ c_{12} \\ \vdots \\ c_{1m_1} \end{array} \\ \vdots \\ D_i \; \begin{array}{c} c_{i1} \\ c_{i2} \\ \vdots \\ c_{im_i} \end{array} \\ \vdots \end{array} \begin{array}{c} \begin{array}{ccccc} D_1 & \cdots & D_i & \cdots & D_n \\ C_{11} \ldots C_{1m_1} & \cdots & C_{i1} \ldots C_{im_j} & \cdots & C_{n1} \ldots C_{nm_n} \end{array} \\ \begin{bmatrix} T_c^{\alpha 11} & \cdots & T_c^{\alpha 1j} & \cdots & T_c^{\alpha 1n} \\ \vdots & & \vdots & & \vdots \\ T_c^{\alpha i1} & \cdots & T_c^{\alpha ij} & \cdots & T_c^{\alpha in} \\ \vdots & & \vdots & \ddots & \vdots \\ T_c^{\alpha n1} & \cdots & T_c^{\alpha nj} & \cdots & T_c^{\alpha nn} \end{bmatrix} \end{array} \quad (9)$$

$$D_n \quad \begin{matrix} c_{n1} \\ c_{n2} \\ \vdots \\ c_{nm_n} \end{matrix}$$

There are several groups/dimensions in T_C matrix. All the groups/dimensions are normalized in itself by dividing the all elements to row sums (Eq. 10 and 11).

$$T_c^{12} = \begin{matrix} & c_1 & \cdots & c_i & \cdots & c_n \\ c_1 & T_c^{\alpha 11} & \cdots & T_c^{\alpha 1j} & \cdots & T_c^{\alpha 1n} \\ \vdots & \vdots & & \vdots & & \vdots \\ c_i & T_c^{\alpha i1} & \cdots & T_c^{\alpha ij} & \cdots & T_c^{\alpha in} \\ \vdots & \vdots & & \vdots & \ddots & \vdots \\ c_n & T_c^{\alpha n1} & \cdots & T_c^{\alpha nj} & \cdots & T_c^{\alpha nn} \end{matrix} \quad \begin{matrix} \rightarrow & t_1^{12} = \sum_{j=1}^{m_2} t_{1j}^{12} \\ & \vdots \\ \rightarrow & t_i^{12} = \sum_{j=1}^{m_2} t_{ij}^{12} \\ & \vdots \\ \rightarrow & t_{m_1}^{12} = \sum_{j=1}^{m_2} t_{m_1 j}^{12} \end{matrix} \tag{10}$$

$$T_c^{\alpha 12} = \begin{matrix} & c_1 & \cdots & c_i & \cdots & c_n \\ c_1 & t_{11}^{12}/t_1^{12} & \cdots & t_{1j}^{12}/t_1^{12} & \cdots & t_{1m_2}^{12}/t_1^{12} \\ \vdots & \vdots & & \vdots & & \vdots \\ c_i & t_{i1}^{12}/t_i^{12} & \cdots & t_{ij}^{12}/t_i^{12} & \cdots & t_{im_2}^{12}/t_i^{12} \\ \vdots & \vdots & & \vdots & \ddots & \vdots \\ c_n & t_{m_1 1}^{12}/t_{m_1}^{12} & \cdots & t_{m_1 j}^{12}/t_{m_1}^{12} & \cdots & t_{m_1 m_2}^{12}/t_{m_1}^{12} \end{matrix} = \begin{bmatrix} t_{11}^{\alpha 12} & \cdots & t_{1j}^{\alpha 12} & \cdots & t_{1m_2}^{\alpha 12} \\ \vdots & & \vdots & & \vdots \\ t_{i1}^{\alpha 12} & \cdots & t_{ij}^{\alpha 12} & \cdots & t_{im_2}^{\alpha 12} \\ \vdots & & \vdots & \ddots & \vdots \\ t_{m_1 1}^{\alpha 12} & \cdots & t_{m_1 j}^{\alpha 12} & \cdots & t_{m_1 m_2}^{\alpha 12} \end{bmatrix} \tag{11}$$

$$W = (T_C^{\alpha})^T = \begin{matrix} & & D_1 & \cdots & D_i & \cdots & D_n \\ & & C_{11} \ldots C_{1m_1} & \cdots & C_{i1} \ldots C_{im_j} & \cdots & C_{n1} \ldots C_{nm_n} \\ D_1 & \begin{matrix} c_{11} \\ c_{12} \\ \vdots \\ c_{1m_1} \end{matrix} & W_{11} & \cdots & W_{1j} & \cdots & W_{1n} \\ \vdots & & \vdots & & \vdots & & \vdots \\ D_i & \begin{matrix} c_{i1} \\ c_{i2} \\ \vdots \\ c_{im_i} \end{matrix} & W_{i1} & \cdots & W_{ij} & \cdots & W_{in} \\ & & \vdots & & \vdots & \ddots & \vdots \\ \vdots & & W_{n1} & \cdots & W_{nj} & \cdots & W_{nn} \end{matrix} \tag{12}$$

$$D_n \quad \begin{matrix} c_{n1} \\ c_{n2} \\ \vdots \\ c_{nm_n} \end{matrix}$$

W_{ij} denotes the principal eigenvector of the influence of the criteria in the j th cluster compared to i th cluster. If the j th cluster has no influence on the i th cluster $W_{ij} = 0$.

Step 6: *Obtaining the Weighted Supermatrix*

By multiplying the unweigted supermatrix and normalized total influence matrix, the weighted supermatrix is obtained.

$$T_D = \begin{bmatrix} t_D^{11} & \cdots & t_D^{1j} & \cdots & t_D^{1n} \\ \vdots & & \vdots & & \vdots \\ t_D^{i1} & \cdots & t_D^{ij} & \cdots & t_D^{in} \\ \vdots & & \vdots & \ddots & \vdots \\ t_D^{n1} & \cdots & t_D^{nj} & \cdots & t_D^{nn} \end{bmatrix} \tag{13}$$

$$T_D^{\alpha} = \begin{bmatrix} t_{11}/t_1 & \cdots & t_{1j}/t_1 & \cdots & t_{1n}/t_1 \\ \vdots & & \vdots & & \vdots \\ t_{i1}/t_i & \cdots & t_{ij}/t_i & \cdots & t_{in}/t_i \\ \vdots & & \vdots & \ddots & \vdots \\ t_{n1}/t_n & \cdots & tj/t_n & \cdots & t_{nn}/t_n \end{bmatrix} \tag{14}$$

Weighted supermatrix W^{α} is calculated as Eq (15).

$$W^{\alpha} = T_D^{\alpha} W = \begin{bmatrix} t_D^{\alpha 11} \times W^{11} & \cdots & t_D^{\alpha 1j} \times W^{i1} & \cdots & t_D^{\alpha 1n} \times W^{n1} \\ \vdots & & \vdots & & \vdots \\ t_D^{\alpha i1} \times W^{1j} & \cdots & t_D^{\alpha ij} \times W^{ij} & \cdots & t_D^{\alpha in} \times W^{nj} \\ \vdots & & \vdots & \ddots & \vdots \\ t_D^{\alpha n1} \times W^{1n} & \cdots & t_D^{\alpha nj} \times W^{in} & \cdots & t_D^{\alpha nn} \times W^{nn} \end{bmatrix} \tag{15}$$

Step 7: *Calculating the overall priorities*

In practice as long as the limiting supermatrix becomes stable, the process of raising power *h* can be stopped to get the final influential weights of each criterion (Shen et al. 2013). So the ANP weights are achieved.

$$\lim_{h\to\infty}(W^{\alpha})^{h} \tag{16}$$

4. APPLICATION THE DANP METHOD TO RESTAURANT SUPPLY CHAIN PERFORMANCE METRICS

Cho et al. (2012) have made a comprehensive literature review on measuring performance of service supply chain management. They determined 3 assessment areas (Service Supply Chain Operation, Customer Service and Corporate Management), 10 dimension or main performance criteria (Responsiveness, Flexibility, Reliability, Tangibles, Assurance, Empathy, Profitability, Cost, Asset and Resource Utilization) and 28 sub criteria, in other words performance metrics. These assessment areas, dimensions and suitable 27 performance criteria were used in this paper.

Cho et al. (2012) used fuzzy AHP method to weight the service supply chain performance dimensions and criteria. AHP is a linear method that assumes hierarchical relations between dimensions and criteria; in fact dimensions/criteria can affect each other. So, we aimed to generate the relation network structure of performance dimensions/criteria of service supply chain and determine the most important performance dimensions and criteria. For this purpose we applied DANP method on a restaurant supply chain. We leagued together with the executives of a restaurant, services in Izmir-Turkey to obtain the direct influence matrix. They were asked to give ratings for each criterion influence degree on other criteria with a five point scale ranging from 0 (no influence) to 4 (very high influence). The consensus results of the experts on pairwise comparisons have been reflected to direct influence matrix A (see Table 1). Indeed, the initial direct influence matrix is a quite large (27×27) matrix. Table 1 shows a small part of the matrix. By use of Eq. (2, 3, 4) the Total influence matrix T for criteria (Table 2) and dimensions (Table 3) are derived.

Table 1. Direct influence matrix A

	Y1	Y2	Es	G1	G2	G3	G4	G5	G6	G7	G8	···
Y1	0,00	0,00	0,00	1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	···
Y2	0,00	0,00	0,00	3,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	···
Es	1,00	4,00	0,00	4,00	0,00	2,00	2,00	3,00	3,00	3,00	3,00	···
G1	2,00	4,00	4,00	0,00	3,00	4,00	4,00	4,00	4,00	4,00	4,00	···
G2	2,00	4,00	2,00	4,00	0,00	0,00	2,00	2,00	0,00	3,00	2,00	···

G3	0,00	0,00	3,00	2,00	0,00	0,00	4,00	3,00	4,00	4,00	4,00	⋯
G4	0,00	2,00	4,00	4,00	0,00	4,00	0,00	4,00	2,00	4,00	4,00	⋯
G5	1,00	4,00	2,00	4,00	1,00	2,00	4,00	0,00	3,00	4,00	4,00	⋯
G6	0,00	4,00	4,00	4,00	3,00	4,00	4,00	4,00	0,00	4,00	4,00	⋯
G7	0,00	4,00	4,00	4,00	3,00	2,00	2,00	4,00	4,00	0,00	4,00	⋯
G8	0,00	4,00	4,00	4,00	3,00	1,00	3,00	4,00	4,00	4,00	0,00	⋯
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋱

Table 2. Total Influence Matrix T for Criteria (T_C)

	Y1	Y2	Es	G1	G2	G3	G4	G5	G6	G7	G8	⋯	Row Sum (d_i)
Y1	0,02	0,05	0,05	0,08	0,04	0,04	0,05	0,06	0,05	0,06	0,05	⋯	0,07
Y2	0,04	0,10	0,10	0,17	0,08	0,09	0,11	0,12	0,10	0,12	0,10	⋯	0,14
Es	0,19	0,52	0,47	0,61	0,33	0,46	0,54	0,60	0,51	0,58	0,52	⋯	0,47
G1	0,25	0,65	0,66	0,70	0,46	0,61	0,72	0,77	0,65	0,74	0,67	⋯	5,33
G2	0,15	0,38	0,35	0,44	0,23	0,29	0,37	0,41	0,32	0,41	0,36	⋯	2,83
G3	0,15	0,41	0,47	0,52	0,29	0,39	0,52	0,54	0,48	0,53	0,49	⋯	3,77
G4	0,17	0,49	0,53	0,60	0,32	0,49	0,51	0,61	0,49	0,59	0,53	⋯	4,15
G5	0,19	0,52	0,50	0,61	0,34	0,46	0,57	0,55	0,51	0,59	0,54	⋯	4,17
G6	0,22	0,65	0,66	0,77	0,47	0,61	0,72	0,77	0,60	0,74	0,67	⋯	5,35
G7	0,20	0,59	0,59	0,69	0,42	0,52	0,61	0,69	0,59	0,61	0,61	⋯	4,74
G8	0,20	0,59	0,59	0,69	0,42	0,50	0,63	0,69	0,59	0,66	0,54	⋯	4,72
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋱	
Column sum (r_i)	0,06	0,15	0,47	5,03	2,96	3,88	4,66	5,03	4,21	4,87	4,41		

Table 3. Total Influence Matrix T for Dimensions (T_D)

	Y	Es	G	MD	T	E	K	M	V	KK	d_i	r_i	$d_i - r_i$	$d_i + r_i$
Y	0,05	0,08	0,08	0,08	0,14	0,12	0,11	0,07	0,04	0,09	0,86	2,52	-1,66	3,38
Es	0,36	0,47	0,52	0,47	0,65	0,54	0,51	0,46	0,42	0,57	4,96	3,64	1,32	8,60
G	0,36	0,54	0,55	0,49	0,63	0,56	0,52	0,48	0,43	0,60	5,17	3,85	1,32	9,02
MD	0,40	0,59	0,60	0,52	0,72	0,59	0,57	0,50	0,47	0,64	5,59	3,51	2,08	9,10
T	0,07	0,09	0,10	0,09	0,12	0,16	0,15	0,08	0,11	0,11	1,09	4,63	-3,53	5,72
E	0,31	0,43	0,44	0,39	0,56	0,45	0,46	0,35	0,36	0,48	4,23	3,92	0,31	8,15
K	0,24	0,33	0,37	0,36	0,41	0,36	0,33	0,29	0,30	0,41	3,39	3,82	-0,44	7,21
M	0,12	0,20	0,22	0,21	0,23	0,19	0,20	0,21	0,17	0,21	1,96	3,33	-1,36	5,29
V	0,24	0,37	0,39	0,39	0,48	0,38	0,40	0,37	0,34	0,47	3,85	3,15	0,70	7,00
KK	0,37	0,55	0,57	0,52	0,68	0,57	0,57	0,51	0,48	0,63	5,47	4,20	1,27	9,67

The row sums (d_i) and column sums (r_i) of total influence matrix's calculated (see in Table 3 and Table 4). The net effect and central role of criteria and dimensions are shown in Table 5. The criteria/dimensions that have positive net effect, influence the other criteria/dimensions and they named 'dispatchers'; others that have negative net effect value are influenced criteria/dimensions and they named 'receivers'. On the other hand, the dimensions/criteria have higher central role ($\mathbf{d_i + r_j}$) value have stronger relationships with other dimensions/criteria and vice versa (Chen et. al, 2011).

It can be seen in Table 4 that Resource Utilization (KK), Tangibles (MD), Reliability (G) and Flexibility (Es) have stronger relationships with other performance dimensions. They are dispatchers and most effective dimensions on others for the case restaurant. Responsiveness (Y), Assurance (T), Profitability (K) and Cost (M) dimensions are receivers. If the restaurant wants to improve Responsiveness (Y) performance, it would pay more attention to Resource Utilization (KK), Tangibles (MD). Because these are the most influential dimensions on Responsiveness (Y). Likewise, Assurance (T), Profitability (K) and Cost (M) dimensions are more affected by Resource Utilization (KK), Tangibles (MD), Reliability (G) and Flexibility (Es) (see in Table 3). If the criteria are evaluated in a similar way Quality of Service (G1) has the most important rating ($d_i + r_i = 10{,}35$) in central role; whereas Service Delivery (Y1) has the least effect on the other criteria ($d_i + r_i = 0{,}13$). Effectiveness of Scheduling Techniques (KK4) has the greatest net effect ($d_i - r_i = 0{,}54$) on other criteria and The Customer Service Order Path (G5) is the most influenced criterion ($d_i - r_i = -0{,}86$).

Table 4. Central Roles and Net Effects of the Criteria

Dimensions/Criteria	***Row Sum*** (d_i)	***Column Sum*** (r_i)	***Net Effect*** ($d_i - r_i$)	***Central Role*** ($d_i + r_i$)
Y	**0,86**	**2,52**	**-1,66**	**3,38**
Y1	0,07	0,06	0,01	0,13
Y2	0,14	0,15	-0,01	0,29

Es	**4,96**	**3,64**	**1,32**	**8,60**
G	**5,17**	**3,85**	**1,32**	**9,02**
G1	5,33	5,03	0,30	10,35
G2	2,83	2,96	-0,13	5,78
G3	3,77	3,88	-0,12	7,65
G4	4,15	4,66	-0,50	8,81
G5	4,17	5,03	-0,86	9,20
G6	5,35	4,21	1,14	9,56
G7	4,74	4,87	-0,13	9,60
G8	4,72	4,41	0,30	9,13
MD	**5,59**	**3,51**	**2,08**	**9,10**
MD1	0,93	1,01	-0,08	1,95
MD2	1,13	1,05	0,08	2,18
T	**1,09**	**4,63**	**-3,53**	**5,72**
E	**4,23**	**3,92**	**0,31**	**8,15**
E1	0,63	0,89	-0,26	1,53
E2	1,09	0,83	0,26	1,93
K	**3,39**	**3,82**	**-0,44**	**7,21**
M	**1,96**	**3,33**	**-1,36**	**5,29**
M1	0,74	0,57	0,17	1,31
M2	0,66	0,65	0,02	1,31
M3	0,47	0,65	-0,18	1,12
V	**3,85**	**3,15**	**0,70**	**7,00**
V1	0,65	0,68	-0,04	1,33
V2	0,73	0,69	0,04	1,43
KK	**5,47**	**4,20**	**1,27**	**9,67**
KK1	3,12	3,07	0,05	6,19
KK2	3,05	3,07	-0,02	6,12
KK3	3,45	3,50	-0,06	6,95
KK4	3,48	2,94	0,54	6,42
KK5	2,56	3,07	-0,51	5,64

As a result of DEMATEL technique the graph diagrams and network structures are constituted (see Figure 2). Because of the complicated network structure of the dimensions' relations, the relation map and graph diagram is shown separately.

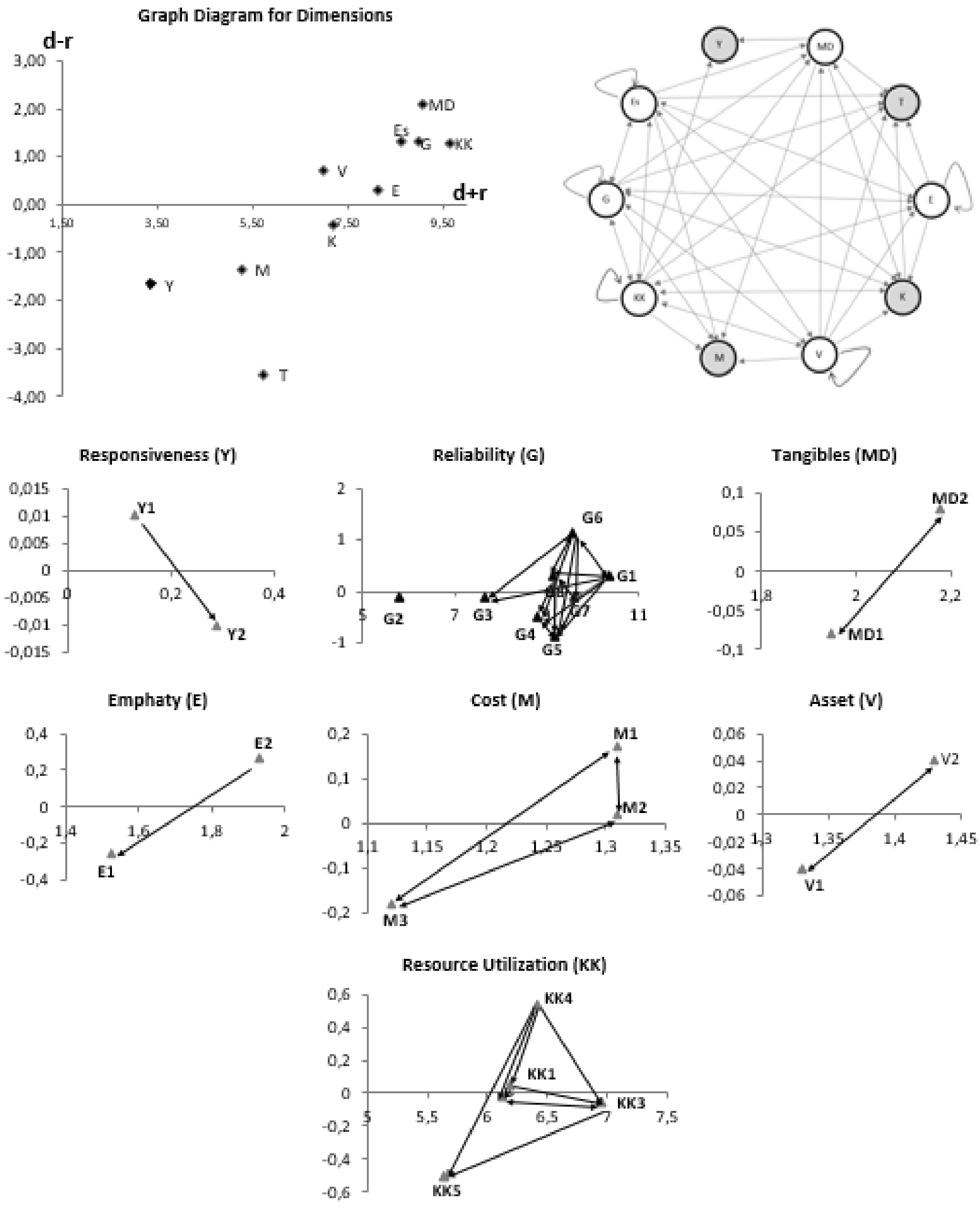

Figure 2. Graph and Network Diagrams of Total Relations

According to analyze results Service Supply Chain Operations (HTZY) is the most important assessment area with a weight of 0,417. In this assessment area Reliability (G) dimension has the first priority (0,388). Flexibility (Es) (0,362) and Responsiveness (Y) (0,250) follow Reliability (G). Second most important assessment area is Customer Service (MH) (0,402) for the case restaurant. The first to third performance dimensions are Assurance (T) (0,381), Tangibles (MD) (0,286) and Empathy (E) (0,285) in Customer Service area. Corporate Management (KY) is the least important area for the case restaurant supply chain performance with a weight of 0,181). Weights of the dimensions that are included by Corporate Management from greatest to least range are Resource Utilization (KK) (0,285), Profitability (K) (0,274), Cost (M) (0,226) and Asset (V) (0,214).

The global weights are shows in Table 5 that the Reliability (G) is the most important dimension with the weight of 0,162 among the 10 performance dimensions; whereas Asset (V) is the least important dimension (0,039). Within 27 performance criteria, Customer Satisfaction (0,153) is the most effective criterion on the restaurant supply chain performance. Flexibility (Es) and Customer Query Time (Y2) follow Customer Satisfaction. On the other hand, Capacity Utilization (KK1), Total Cycle Time (KK2), Effectiveness of Scheduling Techniques (KK4) and Operating Ratio of Actual to Planning Working Hours (KK5) have not significant impact on restaurant supply chain performance according to the expert group. All results are presented in Table 5.

Table 5. Local and Global Weights of Criteria and Dimensions

Assessment Areas	*Criteria*	*Local Weights*	*Ranking Local Weights*	*Global Weights*	*Ranking Global Weights*
Service Supply Chain Operation (HTZY) (0,417)	**Responsiveness (Y)**	**0,250**	**(3)**	**0,104**	**(6)**
	Service Delivery (Y1)	0,277	2	0,029	9
	Customer Query Time	0,723	1	0,075	3
	Flexibility (Es)	**0,362**	**(2)**	**0,151**	**(3)**
	Flexibility (Es)	1	1	0,151	2
	Reliability (G)	**0,388**	**(1)**	**0,162**	**(1)**
	Quality Of Service (G1)	0,145	1	0,023	10
	Employee Loyalty (G2)	0,086	8	0,014	15
	Supplier Risk Sharing	0,114	7	0,018	14
	Quality Of Supplier's	0,134	4	0,022	11
	The Customer Service	0,143	2	0,023	10
	Accuracy Of Forecasting	0,119	6	0,019	13
	Supporting Service	0,137	3	0,022	11
	Service Order Lead Time	0,123	5	0,020	12
Customer Service (MH) (0,402)	**Tangibles (MD)**	**0,286**	**(2)**	**0,115**	**(4)**
	Range of Service (MD1)	0,492	2	0,057	6
	Service Capacity (MD2)	0,508	1	0,058	5
	Assurance (T)	**0,381**	**(1)**	**0,153**	**(2)**
	Customer Satisfaction (T)	1	1	0,153	1
	Empathy (E)	**0,285**	**(3)**	**0,114**	**(5)**
	Customer	0,519	1	0,059	4
	Customer Relationships	0,481	2	0,055	7
Corporate Management	**Profitability (K)**	**0,274**	**(2)**	**0,050**	**(8)**
	Average customer spend	1	1	0,050	8

(KY)	**Cost (M)**	**0,226**	**(3)**	**0,041**	**(9)**
(0,181)	Total Service Delivery	0,317	3	0,013	16
	Supplier Pricing Against	0,339	2	0,014	15
	Supplier Cost Saving	0,344	1	0,014	15
	Asset (V)	**0,214**	**(4)**	**0,039**	**(10)**
	Rate Of Return On	0,501	1	0,019	13
	Total Cash Flow Time	0,499	2	0,019	13
	Resource Utilization	**0,285**	**(1)**	**0,052**	**(7)**
	Capacity Utilization (KK1)	0,197	2	0,010	18
	Total Cycle Time (KK2)	0,197	2	0,010	18
	Productivity (KK3)	0,225	1	0,012	17
	Effectiveness Of	0,186	4	0,010	18
	Operating Ratio Of Actual	0,195	3	0,010	18

5. CONCLUSION

Although service sector has greater share than manufacturing in many countries' and world's GDP, more of the studies are in manufacturing area about supply chain. But, there is an increasing trend in researches on service sector with understanding the importance of services. Restaurant industry is one of the most popular branch of the service sector.

Performance measurement of the supply chain is necessary and vital for sustainability in the sector. In this paper service supply chain dimensions and criteria were evaluated by DANP method for a case restaurant and results shows that “Service Supply Chain Operations” is the most important area for the expert team. “Reliability” dimension has the highest priority either locally and globally. “Assurance” dimension has second priority in the global weight ranking and “Customer Satisfaction” turned out to be the most important criterion from among the 27 performance metric. “Assurance” is also a receiver and is the most affected dimension. It is influenced by all of other dimensions especially “Empathy”. If the restaurant wants to improve its supply chain performance, it should attach more importance to customer satisfaction, so customer relationships.

Flexibility of the volume, delivery speed, specification etc. is the most important second criteria for restaurants. So, to be attuned to the varying levels of demand, different and individual customer needs is a significant issue that should be considered. The third criterion that has greatest weight is “customer query time”. This reflects that to respond a customer's questions about service delivery problems timely and with required, sufficient information has a significant importance for the firm's performance in customers' mind eye.

As further research, it can be tasted if the analyze results change or not according to the different types of DANP methods. Application can be made with several restaurant and the results can be generalized for the sector. Service supply chain performance metrics can be analyzed for other service areas and they can be evaluated by different hybrid methods.

REFERENCES

Baltacioglu, T., Ada, E., Kaplan, M. D., Yurt, O., and Kaplan, Y. C. (2007). "A New Framework for Service Supply Chains." The Service Industries Journal, 27(2): 105–124.

Bhagwat, R. and Sharma, M.K., (2007). "Performance Measurement of Supply Chain Management: A Balanced Scorecard Approach." Computers and Industrial Engineering, 53: 43-62.

Chan, F.T.S., (2003). "Performance Measurement in a Supply Chain." International Journal of Advanced Manufacturing Technologies, 21: 534-548.

Chang, B., Chang, C.-W. and Wu, C.-H., (2011). "Fuzzy DEMATEL Method for Developing Supplier Selection Criteria." Expert Systems with Applications, 38: 1850–1858.

Chen, C.-H. and Tzeng, G.-H., (2011). "Assessment Model for Improving Educational Curriculum Materials Based on the DANP Technique with Grey Relational Analysis." International Journal of Information Systems for Logistics and Management, 6(2): 23-36.

Chen, F.-H., Hsu, T.-S. and Tzeng, G.-H., (2011). "A Balanced Scorecard Approach to Establish a Performance Evaluation and Relationship Model for Spring Hotels Based on a Hybrid MCDM Model Combining DEMATEL and ANP." International Journal of Hospitality Management, 30: 908-932.

Cheng, C.-C., Chen, C.-T., Hsu, F.-S. and Hu, H.-Y., (2012). "Enhancing Service Quality Improvement Strategies of Fine-Dining Restaurants: New Insights from Integrating A Two-Phase Decision-Making Model of IPGA and DEMATEL Analysis." International Journal of Hospitality Management, 31: 1155– 1166.

Cho, D.W., Lee, Y.H., Ahn, S.H. and Hwang, M.K., (2012). "A Framework for Measuring the Performance of Service Supply Chain Management." Computers & Industrial Engineering, 62: 801-818.

Çınar, Y., (2013). "Kariyer Tercih Probleminin Yapısal bir Modeli ve Riske Karşı Tutumlar: Olasılıklı DEMATEL Yöntemi Temelli Bütünleşik Bir Yaklaşım." Sosyoekonomi, 2013-I: 158-185.

Ellram, L., Tate, W., and Billington, C. (2004). "Understanding and Managing the Services Supply Chain." Journal of Supply Chain Management, 40(4): 17–32.

Fitzgerald, L. and Moon, P., (1996). *Performance Measurement in Service Industries: Make It Work*. London: CIMA Publishing.

Giannakis, M. (2011). "Management of Service Supply Chains With a Service Oriented Reference Model: The Case of Management Consulting Source." Supply Chain Management: An International Journal, 16(5): 346-361.

He, T., Ho, W. and Xu, X.F. (2010). "A Value-oriented Model for Managing Service Supply Chains." International Conference on Industrial Engineering and Engineering Management (IEEM), 193-197.

Horng, J.-S., Liu, C.-H., Chou, S.-H., Tsai, C.-Y., (2013). "Creativity as a Critical Criterion for Future Restaurant Space Design: Developing a Novel Model with DEMATEL Application." International Journal of Hospitality Management, 33: 96−105.

Hung, Y.-H., Huang, T.-L., Hsieh, J.-C., Tsuei, H.-J. Cheng, C.-C. and Tzeng, G.-H., (2012). "Online Reputation Management for Improving Marketing by Using a Hybrid MCDM Model." Knowledge-Based Systems, 35: 87-93.

Kulkarni, P.P. and Khot, A.P. (2012). "Supply Chain Performance Measurement", MPGI National Multi Conference, 3-7.

Li, S., Rao S.S., Ragu-Nathan T.S. and Ragu-Nathan, B. (2005). "Development and Validation of a Measurement Instrument for Studying Supply Chain Management Practices." Journal of Operations Management, 23(6): 618-641

Lin, R.-J., Chen, R.-H. and Nguyen, T.-H., (2011). "Green Supply Chain Management Performance in Automobile Manufacturing Industry Under Uncertainty." Procedia - Social and Behavioral Sciences, 25: 233 – 245.

Liu, C.H., Tzeng, G.-W. and Lee, M.-H., (2013). "Strategies for Improving Cruise Product Sales Using Hybrid 'Multiple Criteria Decision Making Models." The Service Industries Journal, 33(5): 542-563.

Martin, P.R. and Patterson, J.W. (2009). "On Measuring Company Performance Within A Supply Chain." International Journal of Production Research, 47(9): 2449-2460.

Neely, A., Gregory, M. and Platts, K., (1995). "Performance Measurement System Design: A Literature Review and Research Agenda." International Journal of Operations & Production Management, 15 (4): 80 – 116.

Saaty, T. L., (1996). *Decision Making with Dependence and Feedback: The Analytic Network Process.* Pittsburgh: RWS Publications,

Sengupta, K., Heiser, D., and Koll, L. (2006). "Manufacturing and Service Supply Chain Performance: A Comparative Analysis." Journal of Supply Chain Management, 42(4): 4–15.

Shen, K.-Y., Yan, M.-R. and Tzeng, G.-H., (2013). "Combining VIKOR-DANP Model for Glamor Stock Selection and Stock Performance Improvement." Knowledge Based Systems, http://dx.doi.org/10.106/j.knosys.2013.07.023, (Access date: 07.02.2014).

Su, C.-H., Tseng, H.-L., Furuzuki, T. and Tzeng, G.-H., (2012). "Application DANP with MCDM Model to Explore Smartphone Software." SCIS-ISIS 2012, Kobe, Japan.

Tsai, W.-H. and Hsu, W., (2010). "A Novel Hybrid Model Based on DEMATEL and ANP for Selecting Cost of Quality Model Development." Total Quality Management, 21(4): 439-456.

Tseng, M.L. (2009). "Using The Extension of DEMATEL to Integrate Hotel Service Quality Perceptions into a Cause–Effect Model in Uncertainty." Expert Systems with Applications, 36: 9015–9023.

Tseng, M.-L., (2009). “Application on ANP and DEMATEL to Evaluate the Decision-Making of Municipal Solid Waste Management in Metro Manila.” Environ Monit Assess, 156: 181-197.

Uysal, F., (2012). “An Integrated Model for Sustainable Performance Measurement in Supply Chain.” Procedia - Social and Behavioral Sciences, 62: 689 – 694.

Wang, Y.-L. and Tzeng, G.-H., (2012). “Brand Marketing for Creating Brand Value Based on a MCDM Model Combining DEMATEL with ANP and VIKOR Methods.” Expert Systems with Applications, 39: 5600-5615.

Wu, H.-H., Chen, H.-K. and Shieh, J.-I., (2010). “Evaluating Performance Criteria of Employment Service Outreach Program Personnel by DEMATEL Method.” Expert Systems with Applications, 37: 5219–5223.

Wu, H.-Y., (2012). “Constructing a Strategy Map for Banking Institutions with Key Performance Indicators of the Balanced Scorecard.” Evaluation and Program Planning, 35: 303–320.

Wu, K.-J., Tsang, M.-L. and Vy, T., (2011). “Evaluation the Drivers of Green Supply Chain Management Practices in Uncertainty.” Procedia - Social and Behavioral Sciences, 25: 384 – 397.

Yang, J.-L. and Tzeng, G.-H., (2011). “An Integrated MCDM Technique Combined with DEMATEL for a Novel Cluster Weighted ANP Method.” Expert Systems with Applications, 38: 1417-1424.

Yang, Y.-P. O., Shieh, H.-M., Leu, J.-D. and Tzeng, G.-H., (2008). “A Novel Hybrid MCDM Model Combined with DEMATEL and ANP with Applications.” International Journal of Operations Research, 5(3): 160-168.

Zhan, B. and Zeng, Y. (2011). “Port Service Supply Chain Performance Evaluation Based on GRA. 2nd International Conference on Computing, Control and Industrial Engineering. 421-424.

The World Factbook, https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html, (Access date: 13.05.2014).